Town of Gilmanton Transfer Station

284 Province Rd, Gilmanton

Level II Energy Audit

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Executive Summary

Many buildings in New Hampshire, and throughout the country, use more energy than they need to be safe and comfortable. When energy costs are low, building owners focus on other priorities. However, as energy costs become more of a burden to budgets, building owners seek solutions to reduce costs and improve the comfort of their buildings. The first important step in this process is an energy audit, which recommends cost-effective and appropriate improvements called Energy Efficiency Measures (EEMs). These EEMs are recommended to reduce energy use, but may also have other benefits including improved comfort, indoor air quality, and resiliency. The Resilient Buildings Group (RBG) team assessed the Town of Gilmanton Transfer Station building in Gilmanton, New Hampshire and has determined there are opportunities to increase the building's energy efficiency.

This Level II Energy Audit Report intends to document energy efficiency opportunities for the transfer station. It provides a thorough understanding of the building's current energy performance, the opportunities for improvement, and the costs associated with the implementation of each EEM. The report is also a tool to guide investment decisions that maximize energy reductions and minimize the building's operating costs, as well as improve overall occupant comfort.

RBG analyzed and benchmarked the energy usage of the building and compared it to buildings of similar function and type. During the site visit, RBG examined the existing conditions of the building, its shell, and all pertinent systems. This allowed RBG to understand how energy is consumed on site, to discover energy waste, and to recommend appropriate energy-saving measures to implement.

RBG selected the recommended measures to help the Town of Gilmanton Transfer Station maximize the benefits and minimize the cost of the potential project. If the EEMs are implemented in a different order, the energy savings and the cost savings will differ from this report. Some of the recommended EEMs should be made in conjunction with others to either maximize benefits or for health/safety reasons. If the recommended EEMs are implemented with rebates, grants, or low-interest loans as outlined, this project could generate a higher return on investment and net present value. If the project receives rebates, grants, or loans lower than 5% interest and/or energy prices increase faster than 5% per year, these returns could improve.

Existing Conditions at the Town of Gilmanton Transfer Station

Site

- **Size:** 3,224 ft²
- **Sewer:** Septic system
- **Water:** Private
- **Year built:** The building was originally constructed in 2003.
- **Building Type:** Transfer Station

Shell

- **Number of Levels:** One
- **Foundation and Insulation:** The foundation is poured concrete, slab-on-grade.
- **Exterior Wall Construction and Insulation:** The exterior walls are constructed of 2"x4" wood studs. The walls appear to be insulated with R-11 fiberglass batt insulation.
- **Roof Type and Insulation:** The roof is wood frame trusses with a metal roof. The bailing room and storage room roof is not insulated. The office and bathroom ceiling is insulated with R-19 fiberglass batts (assumed 6").
- **Doors and Windows:**
    - **Windows:** The office windows are double-pane, casement windows with an estimated U-value of 0.28.
    - **Doors:** The doors to the office and storage room are metal insulated doors with glass windows.

Heating, Plumbing, Ventilation, and Air Conditioning

- **Heating Fuel:** Electricity
- **Heat Generation Equipment:** The bailing section has a waste oil furnace that is no longer utilized. The office section is heated by two electric space heaters.
- **Heating Controls:** Each space heater and the waste oil furnace are controlled by integral thermostats.
- **Domestic Hot Water (DHW):** The DHW for the building is heated by an on demand, electric storage tank.
- **Air-Conditioning Equipment:** The office is cooled by a window air conditioner.
- **Air-Conditioning Controls:** The air conditioning is controlled by controls on the window units.
- **Ventilation Equipment**: The bathroom does not appear to be equipped with an exhaust fan.

Electrical

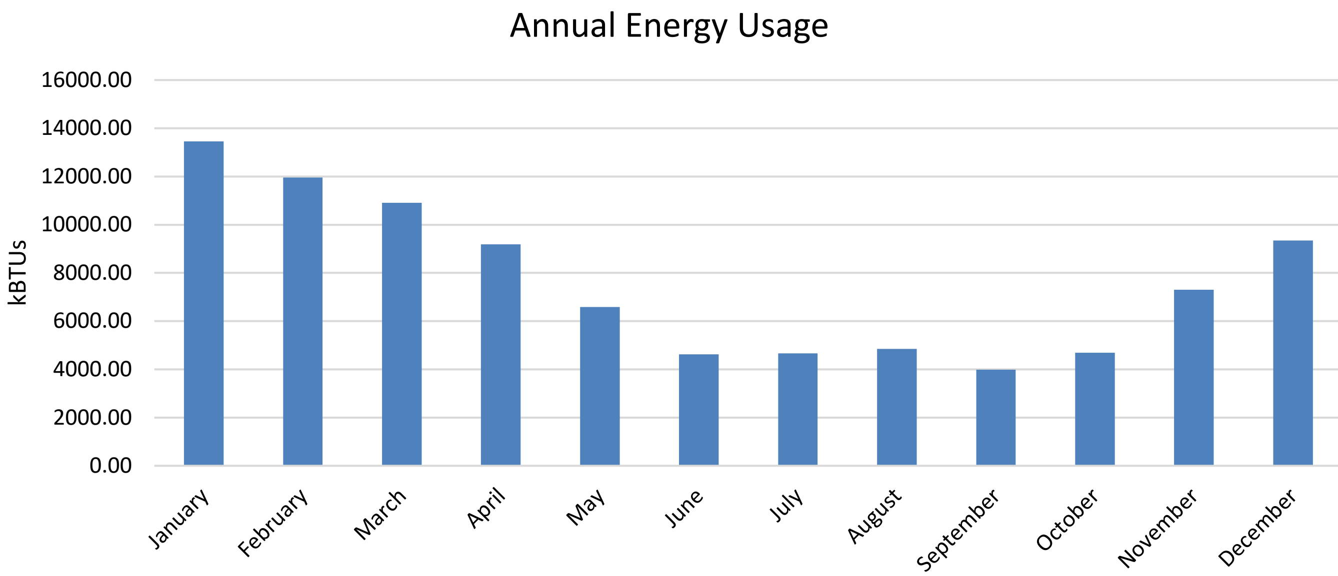
- **Common Area Lighting Type:** The building's interior lighting is T8 fluorescent tube fixtures. The exterior lights are a mix of LED and HID lights.
    - **Lighting Controls:** The interior lighting is controlled by toggle switches. The exterior lights are

controlled by a photocell.

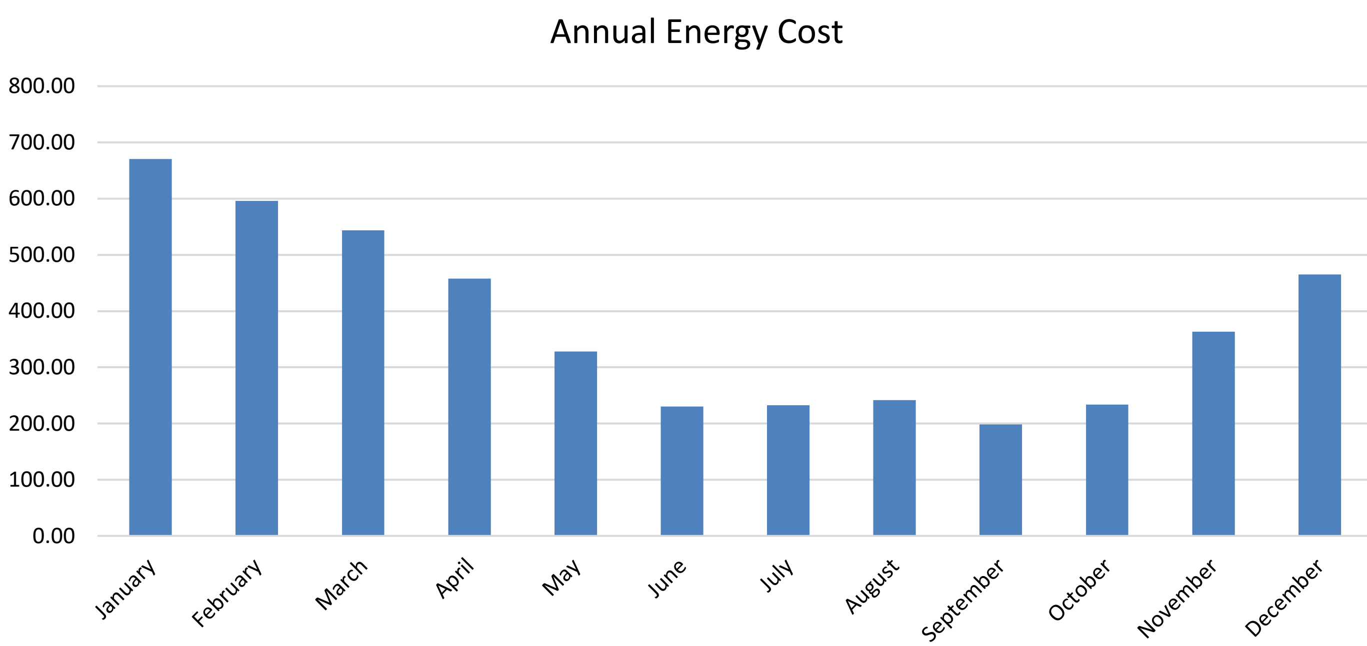
Notable Issues

- The compactor and baling equipment run off inverters.
- The location and equipment operation are well suited for incorporating solar PV electricity generation.
- The baling room is rarely heated. The area is only occupied when the baler is being used, which necessitates the overhead door being open.

Energy Usage and Cost Analysis



Using past utility bills for the garage, we calculated an average yearly consumption 26,826 kWh of electricity, which translates to a total of 91,532 kBTU of energy consumed per year on average.*



The building's average energy costs are $4,560 for electricity per year. It is important to note that the major driver for exceeding the electric baseline is the building's heat demand. Improving the office envelope's robustness will significantly lower the site's electric usage.

*Based off 2 years of electric usage.

Preliminary Building Benchmarking

RBG analyzed the historical energy consumption of this building to calculate a Building Benchmarking rating. Building Benchmarking rates your building's performance on two metrics: Energy Use Intensity (EUI) and Cost Use Intensity (CUI).

EUI is the annual energy use in BTUs (British Thermal Units, usually displayed as kBTUs to signify thousands of BTUs) per square foot of conditioned space in the building (kBTU/SF/YR). CUI displays the annual energy cost per square foot in the building ($/SF/YR).

EUI is often split into two numbers, one providing the annual BTUs used at the site for all purposes (as used in the previous energy tables), and the other combining the site use figure with the additional BTUs required to generate and transmit electrical energy from its source. At RBG, we are chiefly interested in the source number because it provides the most accurate accounting for the total greenhouse gas emissions associated with a building's energy consumption. RBG accounted for both Site and Source kBTUs in the EUI numbers given below.

Our source EUI and CUI are calculated using the 2-year average of electric with the stated conditioned floor area of 3,224 ft^2.

Current EUI/CUI Data:	
Site EUI:	28.3 kBTU/ ft^2/Year
Source EUI:	85.1 kBTU/ ft^2/Year
CUI:	$ 1.41 / ft^2/Year

ENERGY STAR® PortfolioManager®

Technical Reference

Primary Function	Further Breakdown (where needed)	Source EUI (kBtu/ft^2)	Site EUI (kBtu/ft^2)	Reference Data Source - Peer Group Comparison
Other	Other Public Services	**89.3**	**40.1**	CBECS - Other

The national average Source EUI for a typical public service building is 89.3 kBtu/ft^2/Yr and the average Site EUI is 40.1 kBtu/ft^2/Yr. The waste Transfer Station's Source and Site EUIs are both lower than the national average.

Energy Efficiency Measures

Building Envelope

Infiltration and Insulation

A well-sealed and insulated building envelope is an essential element to create a high-performance building and can make a tremendous difference in comfort. Investment in measures to achieve such an envelope will reduce costs in building construction and operation. In a well-sealed and insulated building, heat systems can be smaller and therefore less expensive and less fuel intensive.

The *Energy Impact of Air Leakage in US Office Buildings* study prepared by the Building and Fire Research Laboratory in Maryland, analyzed nationwide infiltration levels. They found that infiltration - when outdoor air leaks into and out of buildings - is responsible for about 15% of the total annual heating load of the typical building. Heating loads rise from heat loss due to ventilation, conduction, and infiltration; all of which depend on Delta T (ΔT). Delta T is the difference between the indoor and outdoor temperatures. However, cooling loads are also heavily impacted by internal heat gains and solar gains, which do not always depend on ΔT between indoor and outdoor temperatures.

Building Envelope Recommendations:

- **B1: Air Sealing.** The envelope of the transfer station is limited to the office and bathroom. RBG recommends weather-stripping the doors from the office and bathroom to the baling room. The seams between the ceiling and exterior walls of the office and the bathroom should be sealed.

- **B2: Insulate Office Walls.** The heated envelope consists of the ceiling and walls of the office and bathroom. RBG recommends installing 2" polyisocyanurate rigid insulation on the bathroom walls adjacent to the baling room and the office walls adjacent to the storage/swap room. This measure will add R-14 of thermal resistance to the wall assembly.

- **B3: Insulate Office Attic.** RBG recommends installing 4" (two layers of 2" polyisocyanurate) rigid insulation over the plywood above the bathroom and office. This will effectively provide an additional R-27 of thermal resistance to the attic assembly, bringing its total thermal resistance up to R-45.

Mechanical System

Once the building envelope is improved, the next step is to address the necessary mechanical improvements. High-efficiency heating, cooling, and ventilating systems, especially when reduced to a size appropriate to the needs of the improved building, can make an immediate difference in expenditures for heating and electricity. Improved piping and ducting systems for distributing heated and cooled air, fresh air, and water throughout the building ensures energy is delivered to the end-use areas with less waste and less cost. Tighter buildings have less infiltration of unconditioned outside air and may need high-performance ventilation systems to provide fresh air to occupants. While this may be an addition to the mechanical systems of some buildings and may add a small amount of electrical use, modern-day ventilators recover up to 80% of the replaced air's heat, thus creating a thermal savings. The result is a more comfortable and productive building; something well worth the additional cost.

The mechanical systems in any building – heating, cooling, ventilating, and plumbing – are the biggest users of fuels and electricity. For the building owner to save energy and money, it is essential that the building's need for all those services be reduced as much as possible. That means making the building envelope as resistant to the loss of conditioned (heated or cooled) air and the gain of excess outside air as is economically feasible.

Mechanical Recommendations:

- **M1: Mechanical Ventilation.** RBG recommends installing an exhaust fan in the bathroom that is vented to the exterior. This is not an energy saving measure, but it will improve the indoor air quality of the office and bathroom space.

- **M2: Heat Pump.** Install a small 9,000 btu per hour heat pump system to heat and cool the office space. Modern day heat pumps can modulate their cooling and heating outputs, making them ideal for small spaces like the office. If possible, reconfigure the bathroom entrance to enter from the offices. This will allow the heating and cooling energy from the heat pump to make it into the bathroom area. Without this reconfiguration, the bathroom will need to continue to be heated with electric resistance heaters.

Electrical System

Improving electrical systems includes analyzing the electrical demands, or the loads, in a building – lighting, appliances, computers, the electrical portion of the operation of mechanical equipment, etc. – and devising ways to reduce their requirements for energy and make them more efficient. Installation of all demand reduction techniques should be implemented first.

After envelope and mechanical improvements, installing high-performance, efficient electricity using devices, remains as a high priority in any building retrofit. The cheapest kilowatt hour is the one you do not need to buy.

Electrical Recommendations:

- **E2:** RBG recommends replacing the T8 lights with LED fixtures.

Renewable Energy

The use of renewable energy to meet buildings' thermal and electrical needs is expanding rapidly. Incentives are now in place at the federal, state, and even some local government levels. Any building upgrade project under consideration today should take advantage of the opportunities presented by renewable energy technologies including: stabilizing energy supply costs, reducing the environmental impact of the greenhouse gas emissions from buildings, and cost savings.

A key goal for RBG in building upgrade projects is to recommend and help implement measures that will dramatically reduce a building's reliance on fossil fuels. Renewable resources can help building owners achieve independence from fossil fuels. The cost and output of the PV Array is estimated using NREL's PVWatts calculator and project costs that RBG has been involved in. These numbers are strictly estimates.

- **R1: Photovoltaic Array.**
  - Option A: Install a roof-mounted 22 kW PV array on the building's roof. This array is projected to generate 28,343 kWh/year assuming the installation of high-efficiency panels. The garage building consumes an average of 26,826 kWh per year, which means the proposed PV system would generate over 100% of the building's average annual electric usage.

Figure 1. Option 1 PV array

  - Option B: Utilize open, non-buildable space on landfill and install a ground-mounted 100 kW PV array. This array is projected to generate 127,189 kWh/year assuming the installation of high-efficiency panels. Installing PV arrays on landfills is common practice, but be sure to acquire the proper analyses and permits before installation.

Figure 2 Option 2 PV array

Financial Modeling Results

The following table identifies each EEM's projected cost, **estimated** annual energy savings and costs savings, simple payback, internal rate of return, and net present value.

The building's energy use was modeled using the EQUEST energy modeling program to estimate energy use, which include breakdowns and energy savings from the recommended EEMs. Cost estimates were derived from several sources: RS Means construction estimating tools, actual contractor estimates, and RBG staff with field knowledge of installed work.

Financial Modeling Results

Assumptions :	Electric		Total Energy per Year	
Baseline Energy Usage:	26,826	kWH	91,530	kBTU
Baseline Energy Cost:	$4,560	Cost	$4,560	Cost
Baseline Unit Cost:	$0.17	($/kWh)		

EEM #	Building Envelope Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
B1	Air Sealing	$600	$145	2,900	4.2	29.0%	$3,361
B2	Insulate Walls	$1,400	$137	2,746	10.2	13.9%	$2,389
B3	Insulate Roof	$3,200	$274	5,492	11.7	12.5%	$4,398

EEM #	Mechanical System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
M2	Heat Pump System	$6,300	$801	16,078	7.9	17.3%	$15,799

EEM #	Electric System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
E1	LED Lights	$3,640	$705	14,149	5.2	24.2%	$15,716

EEM #	Renewable System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
R1A	22 kW PV Array - Option A	$55,000	$4,818	96,706	11.4	12.7%	$78,730
R1B	100 kW PV Array - Option B	$250,000	$21,622	433,969	11.6	12.6%	$350,262

	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
RBG Recommended Package (B1 – B3, M2, & E1)	**$15,140**	**$2,061**	**$41,365**	**7.35**	**18.2%**	**$41,663**
RBG Recommended Project With R1A	**$70,140**	**$6,879**	**$138,072**	**10.20**	**14.0%**	**$120,392**

IRR and NPV assume a 5% inflation rate and a 5% Cost of Capital. Many of these EEMs could qualify for Utility Rebates & Tax Credits.

Next Steps

With the completion of this detailed Level II Energy Audit of the Town of Gilmanton Transfer Station, the building managers should consider potential next steps to take advantage of the energy saving and comfort improving opportunities presented in this report. This Level II Report provides direction and guidance as you design and implement the renovation plans.

To achieve the projected energy savings, the managers must pay careful attention to the proper design and installation of the selected EEMs.

It should be noted that the estimated project costs shown in this report are limited to hard construction costs. The owners should be aware of project design fees and a contingency for unforeseen conditions are not included in the presented estimates but may be required to successfully complete the implementation of the EEMs.

The building examined in this report is an important physical asset and the energy use has significant economic and environmental implications. Proceeding to implement EEMs presents opportunities to reduce costs, improve comfort, and reduce environmental impacts. Please let RBG know if you have any questions about moving forward. RBG would also be able to assist the Town of Gilmanton Transfer Station in obtaining rebates through the NHSaves program.

RESILIENT BUILDINGS

— GROUP —

Superior energy performance

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